

**What is claimed is:**

1. A porous ceramic oxide pre-form comprising porous, sintered ceramic oxide material and substantially continuous ceramic oxide fibers having lengths of at least 5 cm, the porous, sintered ceramic oxide material securing the substantially continuous ceramic oxide fibers in place, wherein the porous, sintered ceramic oxide material extends along at least a portion of the length of the substantially continuous ceramic oxide fibers, wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned.

2. The ceramic oxide pre-form according to claim 1 wherein the substantially continuous ceramic oxide fibers have lengths of at least 10 cm.

3. The ceramic oxide pre-form according to claim 1 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

4. The ceramic oxide pre-form according to claim 3 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

5. The ceramic oxide pre-form according to claim 3 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

6. The ceramic oxide pre-form according to claim 1 wherein the substantially continuous ceramic oxide fibers have a first Young's modulus and the ceramic oxide material has a second Young's modulus, and wherein the first Young's modulus is greater than the second Young's modulus.

7. The ceramic oxide pre-form according to claim 6 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

8. The ceramic oxide pre-form according to claim 6 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

9. The ceramic oxide pre-form according to claim 1 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers.

10. The ceramic oxide pre-form according to claim 9 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

11. The ceramic oxide pre-form according to claim 9 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

12. The ceramic oxide pre-form according to claim 1 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers, wherein at least two of the groupings having a rectangular cross-section.

13. The ceramic oxide pre-form according to claim 1 wherein the ceramic oxide pre-form is elongated and has a rectangular cross-section perpendicular to the length of the substantially continuous ceramic oxide fibers.

5 14. The ceramic oxide pre-form according to claim 1 wherein the ceramic oxide pre-form is elongated and has substantially constant cross-sectional area.

10 15. The ceramic oxide pre-form according to claim 1 wherein the substantially continuous ceramic oxide fibers are encapsulated within the porous, sintered ceramic oxide material.

16. The ceramic oxide pre-form according to claim 1 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

15 17. The ceramic oxide pre-form according to claim 1 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

20 18. A method for making a porous ceramic oxide, the method comprising:

positioning at least one elongated fiber insert in a cavity, the fiber insert comprising substantially continuous ceramic oxide fibers having lengths of at least 5 cm, wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned;

introducing a slurry into the cavity such that a pre-determined portion of the elongated fiber insert is coated with the slurry, the slurry comprising liquid medium and discontinuous ceramic oxide fibers dispersed therein;

30 removing at least a sufficient amount of the liquid medium to cause the discontinuous fibers to consolidate and secure the fiber insert to provide an article

comprising the elongated fiber insert and the discontinuous fibers, wherein the consolidation of the discontinuous fibers extends along at least a portion of the length of the fiber insert;

drying the consolidated article to provide a green ceramic oxide pre-form comprising the elongated fiber insert and the discontinuous fibers, wherein at least one consolidation of the discontinuous fibers secures the fiber insert in place, and wherein the consolidation of the discontinuous fibers extends along at least a portion of the length of the fiber insert; and

heating the green ceramic oxide pre-form to at least one temperature sufficient to provide a porous ceramic oxide pre-form comprising porous, sintered ceramic oxide material securing the substantially continuous ceramic oxide fibers in place, wherein the porous, sintered ceramic oxide material extends along at least a portion of the length of the substantially continuous fibers, and wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned.

19. The method according to claim 18 wherein the substantially continuous ceramic oxide fibers have lengths of at least 10 cm.

20. The method according to claim 18 wherein at least a portion of the discontinuous fibers comprise alpha alumina discontinuous fibers.

21. The method according to claim 18 wherein the substantially continuous, longitudinally aligned, ceramic oxide fibers are encapsulated within the green ceramic oxide material.

22. The method according to claim 18 wherein the fiber insert further comprises fugitive binder material bonding at least a portion of the substantially continuous, longitudinally aligned, ceramic oxide fibers together.

23. The method according to claim 22 wherein the fugitive binder material is selected from the group consisting of wax, polyvinyl alcohol, polyvinyl pyrrolidone, epoxy resin, and combinations thereof.

24. The method according to claim 18 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

25. The method according to claim 24 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

26. The method according to claim 18 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

27. A porous ceramic oxide pre-form comprising:  
a first porous, sintered ceramic article including an aperture for receiving a porous ceramic oxide; and  
a second ceramic article positioned in the aperture, the second ceramic article comprising porous, sintered ceramic oxide material and substantially continuous ceramic oxide fibers having lengths of at least 5 cm, the porous, sintered ceramic oxide material securing substantially continuous ceramic oxide fibers in place, wherein the porous, sintered ceramic oxide material extends along at least a portion of the length of the substantially continuous fibers, and wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned.

28. The ceramic oxide pre-form according to claim 27 wherein the substantially continuous ceramic oxide fibers have lengths of at least 10 cm.

29. The ceramic oxide pre-form according to claim 27 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

5 30. The porous ceramic oxide pre-form of claim 29 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

31. The porous ceramic oxide pre-form of claim 29 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and  
10 secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

32. The porous ceramic oxide pre-form of claim 29 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and  
15 secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

33. The ceramic oxide pre-form according to claim 27 wherein the substantially continuous, longitudinally aligned, ceramic oxide fibers have a first Young's modulus and the ceramic oxide material of the second ceramic article has a second  
20 Young's modulus, wherein the first Young's modulus is greater than the second Young's modulus, and wherein the first porous, sintered ceramic article comprises ceramic oxide material having a third Young's modulus, and wherein the second Young's modulus is greater than the third Young's modulus.

25 34. The porous ceramic oxide pre-form of claim 33 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

30 35. The porous ceramic oxide pre-form of claim 33 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

36. The porous ceramic oxide pre-form of claim 33 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

37. The porous ceramic oxide pre-form of claim 27 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

38. The porous ceramic oxide pre-form of claim 27 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

39. The porous ceramic oxide pre-form of claim 27 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

40. A method for making a porous, sintered ceramic oxide pre-form for an article comprising metal matrix material, the method comprising:

designing an article to comprise metal matrix composite material reinforced, at least in part, with substantially continuous, longitudinally aligned, ceramic oxide fibers having lengths of at least 5 cm, wherein the metal matrix composite material to comprise at least one ceramic oxide pre-form comprising ceramic oxide material extends along at least a portion of the length of the substantially continuous, longitudinally aligned, ceramic oxide fibers, and wherein the substantially continuous, longitudinally aligned, ceramic oxide fibers have a first Young's modulus and the ceramic oxide material has a second Young's modulus, and wherein the first Young's modulus is greater than the second Young's modulus; and

preparing, based on the resulting design, a porous, sintered ceramic oxide pre-form comprising the ceramic oxide material securing the substantially continuous, ceramic oxide fibers in place, wherein the ceramic oxide material extends along at least a portion of the length of the substantially continuous ceramic oxide fibers, and wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned.

41. The method according to claim 40 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

42. The method according to claim 41 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

43. The method according to claim 41 wherein the metal matrix is one of aluminum or an alloy thereof.

44. The method according to claim 40 wherein the substantially continuous ceramic oxide fibers have lengths of at least 10 cm.

45. The method according to claim 40 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

46. The method according to claim 40 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

47. The method according to claim 46 wherein the metal matrix is one of aluminum or an alloy thereof.

48. The method according to claim 46 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

49. The method according to claim 48 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

50. The method according to claim 48 wherein the metal matrix is one of aluminum or an alloy thereof.

51. The method according to claim 40 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

52. The method according to claim 40 wherein the metal matrix is one of aluminum or an alloy thereof.

53. A method for making a porous, sintered ceramic oxide pre-form for an article comprising metal matrix material, the method comprising:

designing an article to comprise metal matrix composite material reinforced, at least in part, with substantially continuous, longitudinally aligned, ceramic oxide fibers having lengths of at least 5 cm;

preparing, based on the resulting design, an elongated pre-form comprising the substantially continuous, longitudinally aligned, ceramic oxide fibers and binder material bonding fibers together;

preparing a green ceramic oxide pre-form comprising green ceramic oxide material extending along at least a portion of the length of the elongated pre-form; and

heating the green ceramic oxide pre-form to provide a porous, sintered ceramic oxide pre-form comprising ceramic oxide material securing the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, wherein the ceramic oxide material extends along at least a portion of the length of the substantially continuous ceramic oxide fibers, and wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned.

54. The method according to claim 53 wherein the substantially continuous ceramic oxide fibers having lengths of at least 10 cm.

55. The method according to claim 53 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

56. The method according to claim 55 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

57. The method according to claim 53 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

58. The method according to claim 57 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

59. The method according to claim 58 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

60. The method according to claim 53 wherein the metal matrix is at least one of aluminum or an alloy thereof.

61. The method according to claim 53 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

62. The method according to claim 61 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

63. A metal matrix composite article comprising a porous ceramic oxide and metal matrix material, wherein the ceramic oxide pre-form comprises

substantially continuous ceramic oxide fibers having lengths of at least 5 cm and a porous, sintered ceramic oxide material extending along at least a portion of the length of the substantially continuous ceramic oxide fibers, wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned, and wherein the porous ceramic oxide material is infiltrated with at least a portion of the metal matrix material extending into the porous, sintered ceramic oxide material.

64. The metal matrix composite article according to claim 63 wherein the substantially continuous ceramic oxide fibers have lengths of at least 10 cm.

65. The metal matrix composite article according to claim 63 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

66. The metal matrix composite article according to claim 63 wherein the metal matrix material is aluminum or an alloy thereof.

67. The metal matrix composite article according to claim 63 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers.

68. The metal matrix composite article according to claim 63 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers, wherein at least two of the groupings having a rectangular cross-section.

69. The metal matrix composite article according to claim 63 wherein the ceramic oxide pre-form is elongated and has a rectangular cross-section perpendicular to the length of the substantially continuous fibers.

70. The metal matrix composite article according to claim 63 wherein the ceramic oxide pre-form is elongated and has substantially constant cross-sectional area.

71. The metal matrix composite article according to claim 63 wherein the substantially continuous ceramic oxide fibers are encapsulated within the porous, sintered ceramic oxide material.

72. The metal matrix composite article according to claim 63 wherein the metal matrix material is aluminum or an alloy thereof.

73. The metal matrix composite article according to claim 63 wherein the article is a brake caliper.

74. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 73 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

75. The metal matrix composite article according to claim 63 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

76. The metal matrix composite article according to claim 75 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

77. The metal matrix composite article according to claim 75 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers.

78. The metal matrix composite article according to claim 75 wherein the metal matrix material is aluminum or an alloy thereof.

5 79. The metal matrix composite article according to claim 75 wherein the article is a brake caliper.

10 80. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 79 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

15 81. The metal matrix composite article according to claim 63 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

20 82. The metal matrix composite article according to claim 81 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

25 83. The metal matrix composite article according to claim 81 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers.

30 84. The metal matrix composite article according to claim 81 wherein the metal matrix material is aluminum or an alloy thereof.

85. The metal matrix composite article according to claim 81 wherein the article is a brake caliper.

86. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 85 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

87. The metal matrix composite article according to claim 63 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

88. The metal matrix composite article according to claim 87 wherein the porous, sintered ceramic oxide material is comprised of alpha alumina.

89. The metal matrix composite article according to claim 87 comprising at least two groupings of the substantially continuous ceramic oxide fibers spaced apart with the porous, sintered ceramic oxide material between the groupings of substantially continuous ceramic oxide fibers.

90. The metal matrix composite article according to claim 87 wherein the metal matrix material is aluminum or an alloy thereof.

91. The metal matrix composite article according to claim 88 wherein the article is a brake caliper.

92. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 91 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

93. A metal matrix composite article comprising a porous ceramic oxide and metal matrix material, wherein the ceramic oxide pre-form comprises:

a first porous, sintered ceramic article including an aperture for receiving a porous ceramic oxide; and

a second ceramic article positioned in the aperture, the second ceramic article comprising porous, sintered ceramic oxide material and substantially continuous ceramic oxide fibers having lengths of at least 5 cm, the porous, sintered ceramic oxide material securing the substantially continuous ceramic oxide fibers in place, wherein the porous, sintered ceramic oxide material extends along at least a portion of the length of the substantially continuous fibers, and wherein the substantially continuous ceramic oxide fibers are essentially longitudinally aligned; and

wherein the porous, sintered ceramic oxide material is infiltrated with at least a portion of the metal matrix material.

94. The metal matrix composite article according to claim 93 wherein the substantially continuous ceramic oxide fibers have lengths of at least 10 cm.

95. The metal matrix composite article according to claim 93 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

96. The metal matrix composite article according to claim 93 wherein the article is a brake caliper.

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97. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 96 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

98. The metal matrix composite article according to claim 93 wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

99. The metal matrix composite article according to claim 93 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

100. The metal matrix composite article according to claim 93 wherein the article is a brake caliper.

101. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 100 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

102. The metal matrix composite article according to claim 93 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place.

103. The metal matrix composite article according to claim 102 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

104. The metal matrix composite article according to claim 102 wherein the article is a brake caliper.

105. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 104 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

106. The metal matrix composite article according to claim 93 wherein the porous, sintered ceramic oxide material has an open porosity of at least 85% by volume and secures the substantially continuous, longitudinally aligned, ceramic oxide fibers in place, and wherein at least a portion of the substantially continuous ceramic oxide fibers is in the form of tows.

107. The metal matrix composite article according to claim 106 wherein the porous, sintered ceramic oxide material of the second ceramic article is comprised of alpha alumina.

108. The metal matrix composite article according to claim 106 wherein the article is a brake caliper.

109. A disc brake for a motor vehicle comprising a rotor; inner and outer brake pads disposed on opposite sides of the rotor and movable into braking engagement

therewith; a piston for urging the inner brake pad against the rotor; and the brake caliper according to claim 108 comprising a body member having a cylinder positioned on one side of the rotor and containing the piston, an arm member positioned on the other side of the rotor and supporting the outer brake pad, and a bridge extending between the body member and the arm member across the plane of the rotor.

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